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## SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING  
JANUARY 1936

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures, the reader is referred to the January 1935 REVIEW, page 24.

Table 1 shows that solar radiation intensities averaged above normal at all three Weather Bureau stations.

Table 2 shows an excess in the amount of total solar and sky radiation at all stations with the exception of Washington, Lincoln, Twin Falls, Riverside, and Ithaca. Beginning with this issue, departures from normal will be published regularly for Ithaca and Friday Harbor in addition to the departures from normal at most of the other stations. Similar departures for Pittsburgh, La Jolla, Mount Washington, and San Juan cannot be published until sufficient records are obtained to establish normals.

Table 3 shows in general comparatively high turbidity factors for January; but, with the exception of the 13th, relatively low water-vapor content of the atmosphere on days when these measurements were made.

No polarization readings were obtained at either Washington or Madison, because of continuous snow or ice cover during the month.

TABLE 1.—Solar radiation intensities during January 1936

[Gram-calories per minute per square centimeter of normal surface]

## WASHINGTON, D. C.

TABLE 1.—Solar radiation intensities during January 1936—  
Continued

[Gram-calories per minute per square centimeter of normal surface]

## WASHINGTON, D. C.—Continued

Date	Sun's zenith distance										Local mean solar time
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time	Air mass									
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
Jan. 21	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm
Jan. 23	2.06	.95	1.10	1.19	1.46	1.23	1.36	1.45	1.24	1.12	2.03
Jan. 24	.66	.85	1.08	1.30	1.46	1.46	1.46	1.46	1.24	1.12	.66
Jan. 27	.64	.85	1.08	1.30	1.46	1.46	1.46	1.46	1.24	1.12	.56
Jan. 28	.58	.68	.86	1.00	1.18	1.11	.78	1.12	1.12	1.12	.66
Means	.91	.81	.89	1.03	1.27	1.20	.99	1.00	.88	.88	1.07
Departures	+ .06	+ 0.3	+ .01	+ .03	+ .06	+ .06	+ .10	+ .07	+ .05	+ .05	-

## MADISON, WIS.

Jan. 14	4.17	-----	.73	.85	-----	-----	-----	-----	-----	-----	4.17
Jan. 23	.23	-----	1.25	1.36	1.56	-----	-----	-----	-----	-----	.38
Jan. 24	.23	1.09	1.23	1.34	1.52	-----	-----	-----	-----	-----	.43
Jan. 30	.71	-----	-----	1.16	1.28	1.49	-----	-----	-----	-----	.81
Jan. 31	.51	-----	-----	1.16	1.28	1.49	-----	-----	-----	-----	.71
Means	(1.09)	1.09	1.21	1.46	1.62	-----	-----	-----	-----	-----	-
Departures	+ .13	+ .03	0.00	+ .11	+ .13	+ .13	+ .10	+ .07	+ .05	+ .05	-

## LINCOLN, NEBR.

Jan. 4	1.78	1.07	1.23	1.30	-----	-----	-----	-----	1.31	1.11	1.00	2.16
Jan. 9	1.78	-----	1.03	1.24	-----	-----	-----	-----	1.31	1.11	1.00	3.00
Jan. 13	1.88	-----	.94	1.12	-----	-----	-----	-----	-----	-----	-----	3.81
Jan. 16	1.78	-----	1.20	-----	-----	-----	-----	-----	-----	-----	1.32	-
Jan. 18	4.17	-----	1.15	1.27	-----	-----	-----	-----	1.29	1.18	1.06	.79
Jan. 20	.71	.93	1.08	1.17	-----	-----	-----	-----	-----	-----	1.96	-
Jan. 21	1.32	-----	1.28	-----	-----	-----	-----	-----	-----	-----	-----	.53
Jan. 22	.91	-----	1.33	-----	-----	-----	-----	-----	1.12	.98	.80	.53
Jan. 25	.38	-----	1.24	-----	-----	-----	-----	-----	-----	-----	-----	.96
Jan. 27	.28	-----	1.06	1.49	-----	-----	-----	-----	-----	-----	-----	.66
Jan. 29	.48	-----	1.17	1.35	1.41	-----	1.41	1.22	1.14	1.00	.96	-
Jan. 30	.53	-----	1.31	1.41	1.58	-----	1.54	1.39	1.24	1.15	.86	-
Means	z1.00x	1.13	1.25	1.49	1.62	(1.48)	1.25	1.10	.98	.88	-	-
Departures	+ .07	+ .08	+ .06	+ .11	+ .13	+ .13	+ .07	+ .05	+ .05	+ .05	-	-

\* Extrapolated.

NOTE.—Since the data for Blue Hill, Mass., have not been received at the time of going to press, they will be included in the next issue of the REVIEW.

Date	Sun's zenith distance										Local mean solar time
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time	Air mass									
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
Jan. 3	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm
Jan. 10	6.02	-----	1.22	1.39	1.35	1.17	-----	-----	-----	-----	4.37
Jan. 13	3.45	-----	-----	-----	1.18	.90	-----	-----	-----	-----	3.45
Jan. 14	5.36	0.75	0.82	.94	1.03	1.01	0.92	0.74	-----	-----	5.36
Jan. 14	3.45	.70	.75	.99	1.24	1.07	1.00	0.80	-----	-----	3.00
Jan. 20	1.52	.90	.96	1.10	1.41	1.37	1.14	.97	.91	1.52	-

## MONTHLY WEATHER REVIEW

JANUARY 1936

TABLE 2.—Average daily totals of solar radiation (direct + diffuse) received on a horizontal surface

Week beginning—	Gram-calories per square centimeter															
	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	Friday Harbor	Ithaca
1936																
Jan. 1	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
	132	106	66	48	73	153	20	6	147	274	301	157	259	122	169	58
Jan. 8																
	130	123	179	103	94	163	27	17	91	277	311	227	230	172	173	73
Jan. 15																
	126	152	210	82	125	277	33	13	157	278	302	256	262	187	65	130
Jan. 22																
	241	238	228	164	214	260	66	31	170	272	292	209	252	263	178	180
Departures from weekly normals																
Jan. 1	-21	-23	-109	-33	-30	+7	-	-2	-18	-	+6	+2	+25	-16	-8	-29
	-22	-11	-6	+21	-14	-7	-	+7	-78	-	+11	+23	-15	+17	-3	-1
Jan. 8	-37	-4	+14	-17	+12	+92	-	-2	-27	-	+27	+47	-11	+5	-25	+9
	+61	+53	+2	+44	+60	+35	-	+5	-20	-	-40	+22	-28	+56	+80	+15
Accumulated departures on Jan. 28																
	-133	+105	-693	+105	+106	+889	-	+56	-1,001	-	+28	+658	-203	+434	+308	-42

## Atmospheric conditions during turbidity measurements

TABLE 3.—Total,  $I_m$ , and screened,  $I_s$ ,  $I_r$ , solar radiation intensity measurements, obtained during January 1936, and determinations of the atmospheric turbidity factor,  $\beta$ , and water-vapor content,  $w$  = depth in millimeters, if precipitated

## AMERICAN UNIVERSITY, WASHINGTON, D. C.

Date and hour angle	Solar altitude	Air mass	$I_m$	$I_s$	$I_r$	$\beta_{I_m-r}$	$\beta_{I_s-r}$	$\beta_{mean}$	$\frac{I_{w=0}}{1.94}$		$\frac{I_{w=0}-I_m}{1.94}$		$w$	Air-mass mass
									Percentage of solar constant					
Jan. 13	° ' m	m	gr. cal.	gr. cal.	gr. cal.	0.079	0.081	0.055	62.8	16.2	mm	>40	N <sub>rc</sub>	
2:48 a. m.	17 52	3.23	0.912	0.844	0.665	.079	.081	.054	63.6	17.1		>40		
2:44 a. m.	18 22	3.15	.931	.846	.666	.074	.083							
Jan. 20	29 36	2.02	1.393	1.162	.933	.035	.020	.028	78.3	8.9	4.7	4.7	P <sub>c</sub>	
0:52 a. m.	29 47	2.01	1.393	1.162	.933	.035	.020	.028	78.3	8.9				
Jan. 21	30 19	1.98	1.266	1.099	.927	.100	.080	.080	66.6	4.4	1.2	1.2	N <sub>re</sub>	
0:40 a. m.	30 27	1.97	1.268	1.100	.928	.100	.080	.080	66.6	4.2				
Jan. 23	30 22	1.97	1.461	1.273	1.017	.040	.010	.025	79.7	6.1	2.0	2.1	P <sub>e</sub>	
0:44 a. m.	30 32	1.96	1.461	1.273	1.017	.040	.010	.025	79.8	6.2				
Jan. 24	28 34	2.08	1.397	1.156	.991	.054	.040	.047	74.1	4.4	1.2	1.2	P <sub>o</sub>	
1:24 a. m.	28 51	2.07	1.461	1.204	.992	.054	.040	.047	74.2	4.2				
Jan. 27	31 20	1.92	1.190	1.060	.879	.120	.074	.087	66.4	6.9	2.6	2.6	P <sub>e</sub>	
0:48 a. m.	31 30	1.91	1.192	1.061	.880	.120	.075	.088	66.6	7.0				

## Atmospheric conditions during turbidity measurements

- Jan. 13. Temperature, 8° C., wind, NW. 12; visibility 12 miles. (No polarization during month; ground snow-covered.)  
 Jan. 20. Temperature, 3° C., wind, NW. 14; visibility 20 miles.  
 Jan. 21. Temperature, 5° C., wind, S. 8; visibility 20 miles.  
 Jan. 23. Temperature, 15° C., wind, NW. 15; visibility 30 miles.  
 Jan. 24. Temperature, 10° C., wind, NW. 12; visibility 50 miles.  
 Jan. 27. Temperature, 8° C., wind, NW. 14; visibility 30 miles.

## BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

Jan. 4	13 35	4.19	1.070	0.770	0.620	0.019	0.027	0.023	67.7	14.3	7.3	N <sub>rc</sub>
Jan. 6	13 35	4.19	.770	.585	.485	—	—	—	—	—	—	N <sub>rc</sub> , N <sub>rf</sub> aloft
Jan. 8	12 21	4.61	.922	.706	.610	—	—	—	—	—	—	P <sub>o</sub>
3:13 a. m.	20 14	2.88	1.260	.897	.746	.038	.050	.044	68.2	5.4	3.2	
1:57 a. m.	25 09	2.35	1.300	.925	.756	.046	.051	.048	71.4	6.6	4.3	
Jan. 10	22 52	2.56	1.255	.903	.720	.037	.025	.031	74.5	11.9	7.0	N <sub>rc</sub> becoming T <sub>w</sub>
1:42 a. m.	26 02	2.28	1.090	.777	.654	.025	.004	.014	80.3	25.7	8.4	P <sub>r</sub>
Jan. 14	13 46	4.13	1.036	.773	.653	.047	.047	.047	60.0	8.4	4.2	N <sub>rc</sub>
0:14 p. m.	26 02	2.28	1.324	.932	.786	.040	.052	.046	72.3	6.3	4.2	
3:02 p. m.	14 16	3.99	1.121	.825	.686	.040	.031	.036	62.1	6.2	3.1	

TABLE 3.—Total,  $I_m$ , and screened,  $I_s$ ,  $I_r$ , solar radiation intensity measurements, obtained during January 1936, and determinations of the atmospheric turbidity factor,  $\beta$ , and water-vapor content,  $w$ =depth in millimeters, if precipitated—Continued

## BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY—Continued

Date and hour angle	Solar altitude	Air mass	$I_m$	$I_s$	$I_r$	$\beta_{I_m-r}$	$\beta_{I_s-r}$	$\beta_{\text{screen}}$	$\frac{I_{s-s}}{I_m}$	$\frac{I_{s-s}-I_m}{I_m}$	$w$	Air-mass type
									Percentage of solar constant			
Jan. 16												
0:28 a. m.	26 23	2.25	1.227	.874	.711	.059	.057	.058	69.1	7.9	5.3	P <sub>e</sub> P <sub>o</sub> , N <sub>rr</sub> aloft
1:58 p. m.	24 59	2.37	1.311	.943	.766	.035	.014	.024	78.0	12.6	8.5	
Jan. 17												
3:04 a. m.	13 59	4.08	1.030	.761	.654	.049	.071	.060	63.8	12.3	6.2	P <sub>e</sub> , P <sub>r</sub> aloft
1:22 a. m.	26 43	2.22	1.293	.930	.752	.046	.029	.038	72.8	8.0	5.4	
1:36 p. m.	23 08	2.54	1.337	.942	.776	.032	.050	.041	71.5	4.5	3.0	
Jan. 20												
2:33 a. m.	18 14	3.18	1.040	.763	.646	.069	.072	.070	71.1	8.0	4.5	P <sub>e</sub>
0:19 p. m.	27 22	2.16	1.309	.970	.788	.028	.029	.028	77.7	7.2	5.4	
2:36 p. m.	15 07	3.79	1.263	.909	.737	.016	.013	.014	72.2	9.2	4.8	
Jan. 21												
3:03 a. m.	14 48	3.86	.900	.704	.595	.080	.062	.071	54.4	9.1	4.7	P <sub>e</sub>
1:15 a. m.	25 22	2.33	1.230	.886	.738	.060	.050	.055	70.0	8.6	5.7	
0:34 a. m.	27 29	2.16	1.250	.900	.740	.070	.074	.072	77.6	15.2	10.4	
Jan. 22												
0:56 a. m.	26 37	2.23	1.150	.813	.684	.083	.144	.114	59.7	2.3	1.4	N <sub>ro</sub>
0:17 a. m.	27 50	2.14	1.240	.856	.729	(?)	.023	.023	79.3	17.4	9.1	
Jan. 24												
0:15 a. m.	28 19	2.10	0.984	.718	.610	.148	.152	.150	55.5	6.4	4.2	P <sub>e</sub> , N <sub>rr</sub> aloft
Jan. 25												
2:00 a. m.	22 43	2.58	1.197	.853	.709	.050	.057	.054	69.0	10.2	6.4	P <sub>e</sub> , N <sub>rr</sub> aloft
0:39 a. m.	27 59	2.12	1.330	.918	.765	.048	.081	.064	70.2	3.8	2.2	
0:15 p. m.	28 34	2.08	1.362	.992	.775	.042	(?)	.042	74.8	6.7	4.7	
2:35 p. m.	19 01	3.05	1.260	.900	.776	.050	.084	.067	60.5	3.8	2.2	
Jan. 26												
2:12 a. m.	21 44	2.69	1.218	.860	.725	.057	.065	.061	65.2	4.3	2.5	P <sub>e</sub> , N <sub>rr</sub> aloft
0:12 a. m.	28 50	2.07	1.361	.927	.764	.036	.089	.052	72.8	4.8	3.3	
3:12 p. m.	15 52	3.61	1.283	.853	.718	.001	.050	.026	69.0	4.9	2.6	
Jan. 28												
2:44 a. m.	18 35	3.11	1.059	.755	.656	.077	.125	.101	53.8	1.4	0.8	P <sub>e</sub>
0:21 a. m.	29 24	2.02	1.476	.923	.746	(?)	.051	.051	74.0	0.2	0.14	
Jan. 29												
3:05 a. m.	16 09	3.57	1.074	.792	.688	.075	.091	.083	54.4	1.9	1.0	P <sub>e</sub> , P <sub>r</sub> aloft
1:03 a. m.	27 57	2.13	1.386	.960	.794	.038	.065	.052	72.5	3.2	2.1	
0:34 p. m.	29 10	2.05	1.446	.990	.812	.075	.049	.062	71.0	(?)	5.2	
1:56 p. m.	24 03	2.45	1.403	.997	.797	.020	.010	.015	78.4	8.2	5.3	
Jan. 30												
2:57 a. m.	17 00	3.39	1.118	.822	.695	.062	.095	.078	56.3	0.6	0.33	P <sub>e</sub> , P <sub>r</sub> aloft
0:18 p. m.	29 48	2.05	1.396	.963	.782	.030	.050	.040	75.3	6.5	4.6	
2:54 p. m.	17 47	3.24	1.173	.799	.673	.024	.072	.048	64.4	6.7	3.8	
Jan. 31												
2:01 a. m.	23 47	2.48	0.787	.575	.497	.165	.200	.182	45.7	6.2	4.0	N <sub>ro</sub>
0:20 p. m.	24 01	2.45	0.805	.575	.497	.149	.200	.174	47.8	7.5	4.8	

Atmospheric conditions during solar radiation measurements, Harvard University  
Blue Hill Observatory

Date and time from apparent noon	Air temperature	Wind, Beaufort scale	Visibility (scale 0-10)	Sky blueness	Cloudiness and remarks		POSITIONS AND AREAS OF SUN SPOTS					
					Date	Eastern standard time	Heliographic		Area		Total area for each day	Observatory
							Diff. in longitude	Longitude	Latitude	Spot	Group	
January 1936	°F.				1936	h m	°	°	°	347	635	Mt. Wilson.
8; 2:31 a. m.	m. 1.4	NW 4	8	7	Jan. 1	11 0	-76.0	298.2	+25.0			
12; 0:39 a. m.	p. 1.1	NW 2	7	7			-21.0	353.2	-12.0			
14; 2:49 a. m.	m. 5.0	NW 5	9	7			-18.0	356.2	+18.0	64		
16; 0:03 p. m.	p. 1.1	W 7	9	7			+2.0	16.2	-4.0	5		
16; 1:43 p. m.	p. 2.5	W 7	9	7			+22.0	36.2	-23.0		201	
17; 1:09 a. m.	m. 3.6	NW 3	9	7			+28.0	42.2	-29.0		61	
20; 1:42 p. m.	m. 7.8	NW 5	10	8			+31.0	45.2	+13.0		21	
21; 1:14 a. m.	m. 6.8	W 3	8	8			+79.0	93.2	+14.0	42		1,376
22; 0:44 a. m.	m. 0.6	SW 5	7	8			-8.0	351.9	-12.0		349	
22; 0:16 p. m.	p. 0.2	SW 5	8	8			-2.0	357.9	+18.5	55		
23; 0:53 a. m.	m. 14.2	WSW 6	8	8			+36.0	35.9	-22.0	334		
24; 0:58 a. m.	m. 12.3	SW 7	8	7			+49.0	48.9	+16.0		7	
25; 2:48 a. m.	m. 12.7	W 5	9	8			+56.0	55.9	-23.0		7	1,291
25; 0:30 a. m.	m. 9.3	W 5	9	8			-49.0	298.8	+27.5	93		617
26; 0:24 p. m.	m. 8.3	W 3	8	8			+4.0	351.8	-11.5		494	
28; 1:09 a. m.	m. 9.2	NW 7	9	7			+11.0	358.8	+19.5	93		
29; 1:17 a. m.	m. 10.3	WNW 5	9	8			+49.5	37.3	-23.0	247		1,544
30; 2:55 a. m.	m. 15.9	NW 3	8	7								
30; 0:30 a. m.	m. 11.0	NNW 2	8	8								
31; 0:26 a. m.	m. 9.8	WNW 3	8	6	No clouds. Moderate to dense haze.							